**COMMENTARY**

# COVID-19 highlights the need to optimize critical care resource use: The role of a respiratory-led multidisciplinary team

Coronavirus disease 2019 (COVID-19) has led to an unprecedented strain on global healthcare systems and has particularly highlighted the scarcity of critical care beds in intensive care. Whilst various strategies have been employed to optimize critical care resource use, including ad hoc approaches to expand bed capacity, the focus has been on improving triage processes and selecting the right patients at the right time, with various multiprinciple allocation frameworks being proposed.[1] However, delays in discharge are also of key importance as they result in high occupancy rates, which reduce service efficiency and responsiveness, increase costs for commissioners and result in critical care capacity being unavailable to other patients. In 2001, the Department of Health (UK) created definitions of different critical care levels that were independent of a patient's clinical needs (Table 1).[2] Therefore, the number/proportion of level 1 bed days spent in critical care has been highlighted as an appropriate quality indicator of the care process by the National Health Service (NHS) Modernisation Agency and NHS England. Finding approaches to decrease the number of level 1 bed days could be essential in increasing intensive care unit (ICU) bed availability during the ongoing COVID-19 pandemic, as well as for future outbreaks and health systems generally.

The Intensive Care National Audit and Research Centre (ICNARC) data has shown that over 60% of discharges from level 3 to level 1 areas were delayed by ≥4 h.[3] As a result, the standard of discharge from adult critical care areas to wards became that discharges should be made within 4 h of decision and within daylight hours. In response, we developed a functioning respiratory-led weekly multidisciplinary team meeting (RMDT) in April 2014 with an aim to improve critical care resource use. Through retrospective analysis of local ICNARC data, we showed a significant reduction in the number of level 1 bed days spent in critical care, due to a reduction in discharge delay to general wards.[4] However, as a result of large-scale organizational changes within Birmingham Heartlands Hospital management, the RMDT ceased in August 2017. We therefore re-analysed our local ICNARC data as part of a quality improvement initiative to see if cessation of the RMDT resulted in an increase in level 1 bed days, and compared two 2-year time periods before and after the RMDT cessation, period 1 (1 August 2014 to 31 August 2016) and period 2 (1 August 2017 and 31 July 2019), respectively. Delay in discharge was defined as critical care

patients with level 1 needs remaining in critical care for more than 24 h and differences were analysed using a single-tailed $t$-test; differences in numbers of delayed discharges were analysed using a chi-square test. Using this approach, we found an increase in the number of critical care level 1 bed days after RMDT cessation from 45 to 75, period 1 to period 2 ($p < 0.002$) (total discharges 767 vs. 818). This corresponded with an increase in delayed discharges from 33 to 96, period 1 to period 2 ($p < 0.001$). This supports out previous demonstration of a reduction in level 1 bed days with the establishment of an RMDT.[4] Furthermore, the same reduction was not contemporaneously observed at the sister hospital site of similar size under the same hospital management with identical policies without an RMDT.[5] This further strengthens the association between RMDT and reduction in level 1 bed days.

Currently, there is little other work specifically looking at factors governing the reduction of level 1 ICU bed days. Potentially because level 1 bed days may be a uniquely UK-based definition. Nevertheless, a reduction of level 1 bed days is equivalent to a reduction in discharge delay from ICU. In the context of COVID-19 and global ICU bed shortages, the need to reduce ICU discharge delay has become a universal concern. The NYU Langone Medical Center had a similar strategy to RMDT to increase capacity during the beginning of COVID-19 pandemic.[6] The hospital created a Discharge Command Centre to coordinate pending discharges from wards and ICU to reduce avoidable delay. To respond to the more extreme pressures, this took place using a twice-daily call with physicians, nurse managers and social work. The hospital also expedited ward-based discharges by providing supplemental oxygen for home self-weaning in COVID-19 patients with an oxygen requirement of <3 L/min. The team found that implementation of the Discharge Command Centre resulted in a 7.7% reduction in observed to expected length of stay. Looking to the future, machine-based learning strategies could also be promising to allow early recognition of patients fit for discharge versus patients at greater risk of readmission following discharge. A single-centre retrospective study has highlighted that the use of a Rothman Index (RI) within an algorithm may be able to predict patients at risk of deterioration post discharge from ICU to wards.[7] The RI is derived from a patient's electronic medical record and includes 26 variables such as vital signs, nursing assessments, laboratory tests and cardiac rhythms. Gotur et al.

**TABLE 1** The 2001 Department of Health (UK) definitions of critical care levels[2]

| Level 0 | Normal ward-based care in an acute hospital |
|---|---|
| Level 1 | Patients at risk of deteriorating or those relocated from a higher level of care |
| Level 2 (also known as 'high-dependency units') | Patients who may need more detailed frequent observation or intervention, including support for single failing organ support |
| Level 3 (also known as 'intensive care units' or 'intensive therapy units') | Patients who require advanced respiratory support alone with or without multiorgan support |

found that an RI score of higher than 50 had lower OR (0.29) of adverse events post discharge.[7] This represents a fairly modest association between RI score and outcomes, and thus is not reliable enough to predict ICU readmission. However, when used in conjunction with clinical expertise, optimized artificial intelligence-based scores could be a helpful tool in prioritizing patients for discharge in the future.

With COVID-19 highlighting the importance of optimal critical care resource use, there is an opportunity for transformative changes of ICUs in the post-COVID-19 era. We see reducing delays in discharge as a key part of optimizing ICU critical care bed resource availability and there is good evidence to support that reducing delay in discharge reduces patient length of stay and increases critical care bed availability. However, this reduction in discharge delay may be associated with an increased likelihood of mortality and ICU readmission in certain high-risk groups of patients.[8] Clearly, there are challenges and competing factors associated with optimal management of ICU beds to reduce discharge delay. In this context, we see the RMDT or an equivalent approach as an important tool in reducing discharge delay and facilitating flow across critical care units and the wider hospital.

**CONFLICT OF INTEREST**
The authors declare they have no competing interests.

Ashwin Balu MB ChB[1]
Alastair Watson PhD[1,2]
Lucie Linhartova FRCA, FFICM[1]
Paul Ellis MRCP[1]
Rahul Mukherjee FRCP (London), FRCP (Edin.), FCCP[1]

[1]Heartlands Hospital, University Hospitals Birmingham, UK
[2]Clinical and Experimental Sciences, Faculty of Medicine, University of Southampton, Southampton, UK
Email: r.mukherjee@bham.ac.uk

**ORCID**
*Alastair Watson* https://orcid.org/0000-0002-6735-2567
*Rahul Mukherjee* https://orcid.org/0000-0003-4466-0660

**REFERENCES**
1. Arabi YM, Azoulay E, Al-Dorzi HM, Phua J, Salluh J, Binnie A, et al. How the COVID-19 pandemic will change the future of critical care. Intensive Care Med. 2021;47:282–91. https://doi.org/10.1007/s00134-021-06352-y.
2. Comprehensive critical care: a review of adult critical care services. Department of Health, London 2000. © Crown Copyright https://webarchive.nationalarchives.gov.uk/+/http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4006585 (accessed 21 May 2021)
3. NHS England. TR1 REVISED Adult Critical Care Timely Discharge. https://www.england.nhs.uk/wp-content/uploads/2016/03/tr1-adlt-crtcl-care-timelydschrg.pdf. Accessed 21 May 2021.
4. Bishopp A, Santana-Vaz N, Raghuraman G, Chakraborty B, Mukherjee R. Effect of a ventilation multidisciplinary meeting on respiratory patients' journey through critical care. Eur Respir J. 2015;46:PA2161. https://doi.org/10.1183/13993003.congress-2015.PA2161.
5. Bishopp A, Santana-Vaz N, Beauchamp B, Chakraborty B, Raghuraman G, Mukherjee R. Comparison of the effect of a ventilation multidisciplinary meeting on utilisation of critical care resources. Thorax. 2015;70 (Suppl 3):A235. http://doi.org/10.1136/thoraxjnl-2015-207770.448.
6. Bains A, Wang E, Duran D, Lee-Riley L, Volpicelli F. Maintaining throughput and reducing discharge delays after increasing capacity during the Covid-19 pandemic: a New York City hospital's experience. NEJM Catal Innov Care Deliv. 2020. https://doi.org/10.1056/CAT.20.0425.
7. Gotur D, Masud F, Paranilam J, Zimmerman J. Analysis of Rothman index data to predict postdischarge adverse events in a medical intensive care unit. J Intensive Care Med. 2020;35:606–10. https://doi.org/10.1177/0885066618770128.
8. Mitchell Forster G, Bihari S, Tiruvoipati R, Bailey M, Pilcher D. The association between discharge delay from intensive care and patient outcomes. Am J Respir Crit Care Med. 2020;202:1399–406. https://doi.org/10.1164/rccm.201912-2418OC.